May 3, 1932. M. E. HASSELL ET AL 1,857,019

FUSE INDICATOR

Filed March 30, 1931

Fig. 1.

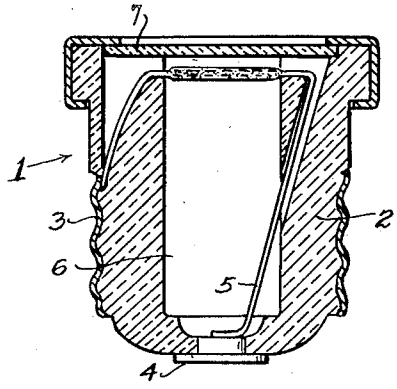


Fig. 2.

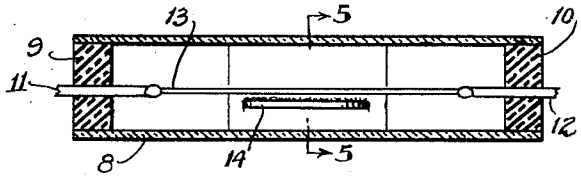


Fig. 5.

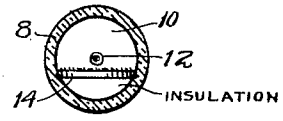


Fig. 3.

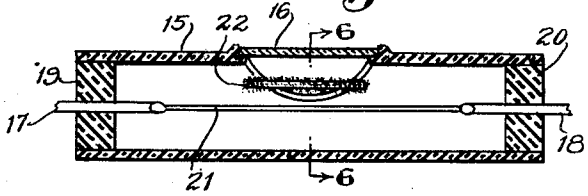


Fig. 6.

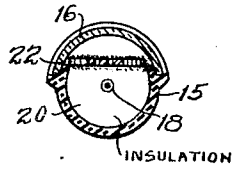


Fig. 4.

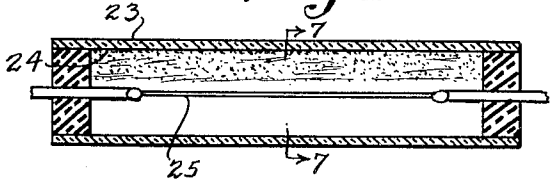
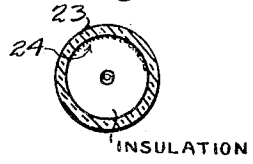


Fig. 7.



Inventors

Marian E. Hassell

and Edward W. Gorham

By

Mason Fenwick & Lawrence

Attorneys

Patented May 3, 1932 1,857,019

UNITED STATES PATENT OFFICE

MARIAN E. HASSELL AND EDWARD W. GORHAM, OF MIAMI, FLORIDA, ASSIGNORS OF THREE-FOURTHS TO SAID HASSELL AND ONE-FOURTH TO SAID GORHAM

FUSE INDICATOR

Application filed March 30, 1931. Serial No. 526,482.

This invention relates to means for providing enclosed safety fuses with an indicator to indicate visually the condition of the fuse strip within the casing, particularly when the fuse has been melted or blown by an excess of current passing therethrough.

The main object of the invention is to provide fuses of the type referred to with some means whereby a transparent casing or a transparent window forming part of the fuse casing becomes coated with coloring matter of sufficient color density to indicate clearly that the fuse strip within the casing has been melted or blown.

Regardless of the indicating color which may be formed on the transparent window or casing of fuses constructed according to this invention, it is to be understood, in every case, that the transparent window or casing remains transparent and colorless until the fuse therein becomes disrupted or blown, or until the fuse strip has attained a predetermined temperature by overloading. The preferred form of our invention employs material in the casing such that when the fuse becomes blown, as by an electric spark, or the temperature of the fuse strip has exceeded a predetermined maximum, a brightly colored deposit is formed on the casing or window to indicate the blowing the fuse. Preferably, the color of the deposit on the window is a bright decided red. However, it is immaterial what particular color may result as an indicator from the practice of this invention, so long as it is sharp and distinct and readily visible.

In every case in the practice of this invention, the change of color or deposit of color on the casing or window is effected by chemical or physical means or by a series of chemical reactions resulting from the interaction of the chemicals provided and an electric spark resulting from the blowing of the fuse or a rise in temperature, due to an excess of current passing therethrough.

In experimenting to obtain these colors, we have obtained the desired effect for all basic colors, and these have been formed on the transparent surface of the casing or window by both physical and chemical means.

In the practice of this invention, we have performed a great many experiments to determine the various colors which may be used as indicators on the transparent casing or window of a fuse or fuse plug. Most of the experiments have been performed with the idea of indicating when the fusible element has blown out or become void. The fusible element in fuses of this type melts when the circuit has become overloaded and forms a break in the circuit which results in the formation of a considerable electric arc. The formation of this arc is the essential requirement to cause the color change which may be readily seen through the transparent window or casing, which is usually formed of mica, cellulose acetate, or glass or similar material.

Although the experiments essentially show that an arc has been formed in the fuse to cause a reaction resulting in a color indication on the transparent casing or window, we have found that the ingredients may be readily changed in proportions to form a fusible medium which fuses at a predetermined temperature, and thereby to give a color indication on the transparent casing or window, which indicates that the circuit of which the fuse forms a part, is overloaded. The fuse in this case is not blown, and the color change is effected solely by heat in excess of a predetermined temperature and indicates the necessity for reducing the current through the circuit, and of course the replacement of the colored fuse by one not colored.

We have found that various mixtures of ingredients may be readily proportioned so that the point of fusion is easily controlled. It therefore appears that in addition to our invention being utilized as an indicator for blown out fuses, it is also intended to be used to indicate the overloading of a circuit, or an excess beyond the predetermined temperature in any kind of temperature indicating device or instrument.

In connection with the various mixtures, referred to in the description of the experiments, hereinafter, it is to be understood that the ingredients are secured to each other

by means of a binder such as collodion, gum arabic, gum tragacanth, or some such adhering medium, which also forms the medium by which the mixture may be coated directly on the fusible wire, or on a small metal disc adapted to be positioned directly under or over the fusible wire.

It is immaterial what particular binder is used for this purpose, so long as it forms a good adhering medium to hold the fusible material to metal or other surface of the fuse plug or casing. However, it is to be noted that gums and resins in their natural form if applied in too large quantities might cause incomplete combustion of the ingredients and result in color interference. Pyroxylin, like collodion, is a nitrated cellulose but is more practical from a commercial standpoint. Collodion is the term applied to purified pyroxylin dissolved in three parts of ether to one part of alcohol. In addition to the usual ether-alcohol solvent for pyroxylin, which composes collodion, there are many other solvents which may be used for pyroxylin or nitrated cellulose. Such solvents may be listed as follows: Various alcohols such as methyl, ethyl, etc., ethyl, butyl and amyl acetates; acetone, benzol diethyl carbonate, tricresyl phosphate; camphor in ethyl alcohol; etc.

By using some form of nitrated cellulose, cellulose acetate, etc., with one of the above or any suitable solvents, or some such similar cellulose nitrate solvent the commercial aspects of applying the fusible ingredients are improved. Collodion is too quick drying and therefore is inferior to some of the above mixtures; however, it is adapted for this purpose and may be used when desired.

Rosin (a resin) if nitrated before used as a binder, will greatly assist in the perfection of the color deposit; and sugars, dextrins, glues, whether nitrated or treated otherwise to assist in proper color deposit, may be used for this purpose.

The following experiments indicate the various methods of causing the necessary color change within the fuse and of the various actual color changes which can be made. It is quite possible by slight changes in proportions of the ingredients to effect corresponding changes in the color deposits:

1. A fusion mixture of black antimony sulfide, potassium chlorate and sulfur, upon being ignited with a spark, causes a brick red deposit to be formed on any transparent surface closely adjacent to the ignited mixture. An actual fusion mixture which is found very satisfactory was formed as follows:

	Parts by weight
Black antimony sulfide (Sb_2S_3)	14
Potassium chlorate ($KClO_3$)	8
Sulfur (flowers)	6

By increasing or decreasing the percentage of potassium chlorate in the mixture, the fusion temperature may be lowered or raised as desired. The fusion temperature of the mixture may also be easily controlled by mixing various proportions of an inert substance, such as kieselguhr (diatomaceous earth), or flour from wheat or other sources, with the fusion mixture. This modification of course is necessary where it is desired to cause the color indication at a predetermined temperature of the fuse wire, or the casing in which the powdered fusion mixture may be placed regardless of whether or not the temperature be due to an overload or to the formation of an arc by melting and rupture of the fuse wire.

2. A fusion mixture of potassium chlorate and black antimony sulfide, upon ignition by a spark, forms an excellent white deposit on the transparent surface or window of the fuse. The following mixture gives excellent results:

	Parts by weight
Potassium chlorate ($KClO_3$)	2
Black antimony sulfide (Sb_2S_3)	7

By varying the above proportions or by mixing with inert substances as above described, these mixtures may also be used as temperature or overload indicators.

3. 20 parts of a fusion mixture of 2 parts by weight of potassium chlorate and 7 parts by weight of black antimony sulfide, mixed with 2 parts by weight of powdered iodine crystals, and fused by an electric spark, form an excellent orange deposit on the transparent surface of the fuse. The intensity of the orange coloring may be varied by varying the proportions of the iodine crystals.

4. 20 parts by weight of a fusion mixture consisting of 2 parts by weight of potassium chlorate and 7 parts by weight of black antimony sulfide, mixed with 4 parts by weight of powdered iodine crystals and one part by weight of powdered antimony (metallic), and fused by an electric spark, form a deposit on the transparent surface of the fuse, which is purple as soon as formed and changes to orange after a short period of time.

5. Using a mixture of 14 parts by weight of black antimony sulfide, 8 parts by weight of potassium chlorate and 6 parts by weight of sulfur flowers with varying amounts of arsenous acid (As_2O_3) a number of experiments were performed giving various color tints. Upon fusion of a small part of these mixtures by means of an electric spark there was a deposit formed on the transparent surface of the fuse varying in color from yellow to brick red. As the amount of arsenous acid was decreased, the color deepened from orange to red. With increasing amounts of arsenous acid, the color lightened from red to orange to yellow.

6. A fusion mixture was made as follows:

	Parts by weight
Potassium nitrate (KNO_3)	20
Carbon	3
Sulfur flowers	3
Phosphorus (amorphous, red)	2

Varying proportions of powdered iodine crystals were mixed with this fusion mixture. Upon fusion of a small amount of this fusion mixture with varying amounts of iodine by means of an electric spark, a deposit was in each case formed on the transparent surface of the fuse. These deposits varied in intensity of color from light purple to a dark deep purple color as the proportions of iodine were increased.

7. The fusion mixture as described in experiment 6 was mixed with varying proportions of arsenous acid (As_2O_3); i. e., 10 grains of the fustion mixture were mixed with ¼ grain of arsenous acid to which a small amount of sulfur flowers were added (½ grain). The amounts of sulfur used should be increased in proportion to the increase of arsenous acid used. By fusion of this mixture by means of an electric spark, a good canary yellow deposit is formed on the transparent surface of the fuse.

8. The fusion mixture as described in experiment 6 was mixed with one half its volume of black antimony sulfide. This mixture was found to be very satisfactory, yet varying proportions may be used. Upon ignition of this mixture by means of an electric spark, there was a good white deposit formed on the transparent surface of the fuse.

9. A fusion mixture was made as follows:

	Parts by weight
Black antimony sulfide	5
Potassium nitrate	8
Sulfur flowers	4½

Upon ignition of a small amount of this fusion mixture by means of an electric spark, there was a brick red deposit formed on the transparent surface of the fuse. This gave an excellent red deposit. This mixture may be heated to a very much higher temperature than when potassium chlorate is used with the two ingredients antimony sulfide and sulfur instead of the potassium nitrate. By slightly increasing the proportion of potassium nitrate, the fusibility is increased or by adding small proportions of potassium chlorate, the same result is obtained.

10. The fusion mixture as described in experiment 6 was mixed with varying amounts of chromic acid and sulfur. Upon fusion of these mixtures by means of an electric spark, various shades of green deposit formed on the transparent surface of the fuse. These shades varied from white-green to deep green. As an example of a specific mixture which gave an excellent deep green deposit after fusion:

	Parts by weight
Ignition mixture as in experiment 6	3
Chromic acid (CrO_3)	3
Sulfur (flowers)	1

Note should here be made that chromic acid is extremely hydroscopic and must therefore be kept out of contact of the air in order to prevent deliquescence. The fuse may be hermetically sealed with wax or some soft material which will be ruptured and allow the gases formed to escape. Another method which worked with satisfaction was to enclose the above mixture in a moisture proof cap made of cellophane or similar material, this cap made to encircle the fusible wire, and upon the rupture of the fusible wire with the resulting spark, the mixture was ignited and the deposit above described formed on the transparent surface of the fuse. Any manner of protecting the chromic acid from contact with the air will not alter the purpose of this experiment.

11. A small amount of chromic acid was mixed with a fusion mixture consisting of 14 parts by weight of antimony sulfide, 8 parts by weight of potassium chlorate, and 6 parts by weight of sulfur. Applying the same conditions to protect the chromic acid from the air as described in experiment 10, upon fusion by means of an electric spark there was a brown deposit formed on the transparent surface of the fuse.

12. The transparent surface of the fuse was coated with agar jelly containing in solution a small amount of mercurous nitrate ($HgNO_3$). 2 parts by weight of the fusion mixture as described in experiment 6 was mixed with 1 part by weight of chromic acid. Applying the same conditions to protect the chromic acid from the air as described in experiment 10, upon fusion by means of an electric spark, there was an orange red color formed on the transparent surface. By the fusion of the mixture there was formed the chromate of mercury on the surface of the transparent window which is an orange red color.

13. The transparent surface of the fuse was coated with agar jelly containing in solution a small amount of barium hydroxide, $Ba(OH)_2$. 2 parts by weight of the fusion mixture as described in experiment 6 were mixed with 1 part by weight of chromic acid. Applying the same conditions to protect the chromic acid as described in experiment 10, upon fusion by means of an electric spark there was an orange red color formed on the transparent surface.

14. The transparent surface of the fuse was coated with agar jelly containing in solution a small amount of antimony nitrate,

$Sb(NO_3)_3$. A fusion mixture was made consisting of 5 parts by weight of sulfur (flowers) and 2½ parts by weight of potassium chlorate. Upon fusion being ignited by means of an electric spark, a yellow coloration was formed on the transparent surface of the fuse.

15. Similar experiments as described in experiment 14 may be and were satisfactorily performed, using the various soluble salts of the metals in solution with the agar agar to coat the transparent surface. Upon ignition of the same sulfur and potassium chlorate mixture the various sulfides of the metals will be formed on the transparent surface of the fuse according to the metallic salt used. A list of the metallic sulfides with their characteristic colors is as follows:

Mercurous sulfide	Black
Lead sulfide	Black
Mercuric sulfide	White to black
Bismuth sulfide	Dark brown
Silver sulfide	Black
Copper sulfide	Black
Cadmium sulfide	Yellow
Arsenic trisulfide	Yellow
Arsenic pentasulfide	Yellow
Antimony trisulfide	Orange
Antimony pentasulfide	Orange
Stannous sulfide	Dark brown
Stannic sulfide	Yellow
Zinc sulfide	White
Manganese sulfide	Flesh
Ferric sulfide	Black
Ferrous sulfide	Black
Colbalt sulfide	Black
Nickel sulfide	Black
Uranium sulfide	Dark brown.

Barium, strontium, calcium and magnesium sulfides are white to yellowish and are phosphorescent.

These sulfides are also formed when a spark is passed through a mixture of gypsum and pyrites which liberates hydrogen sulfide. The hydrogen sulfide forms the above sulfide colors. Hydrogen sulfide may also be produced by a mixture of gypsum and aluminium sulfide. The action of the water liberated by the heat of the spark from the gypsum will decompose the aluminium sulfide forming the required hydrogen sulfide gas. Chromium sulfide may be substituted for the aluminium sulfide.

16. Alloys containing bismuth, antimony or lead such as the fusible alloys do, which when fused will deposit the metallic oxides on the transparent surface of the fuse should be included in the scope of this patent application.

Bismuth trioxide is cream colored.
Antimony trioxide is white.
Lead monoxide is grey.
Lead peroxide is brown.
Cadmium oxide is brown.

These elements and a few more compromise the possible components of the fusible alloys. A fusion of these metals close to the transparent surface will cause white, grey or brown deposits. It is possible to include an oxidizing agent such as a mixture of manganese dioxide and potassium chlorate and upon fusion of a lead alloy, the red lead or lead tetraoxide will be formed on the surface of the transparent window.

18. The transparent surface coated with agar jelly containing in solution just enough sodium bicarbonate to make alkaline and to decolorize a small methyl red content. Methyl red is red in an acid solution and colorless in an alkaline medium. A small amount of the fusion mixture as described in experiment 6 was mixed with a small portion of copper nitrate. Upon fusion, by ignition with an electric spark, the copper nitrate was decomposed and the nitrogen oxide liberated turns the colorless methyl red content of the gel to a brilliant red color. This process comes under the class of color change by chemical indicators.

As so far described, the experiments performed show the possibility of forming a distinctly colored indicator upon a transparent fuse surface by the ignition of a mixture of ingredients within the casing. Several of the experiments also show that it is possible to coat the transparent inner surface of the fuse with a transparent and colorless composition which becomes colored upon fusion by ignition with an electric spark, or by such increase in temperature within the casing as may cause the necessary chemical change in the composition to form the color indicator upon the transparent surface.

The purpose of the foregoing experiments was to obtain by chemical reaction the various colors of the spectrum in such manner as to be easily observed through a transparent medium, and to show that such chemical reactions may be instigated and started either by excessive heat or by ignition with a spark. The experiments cover all chemical methods of color changes caused by chemical changes of ingredients enclosed in a small container, which is either transparent or is fitted with a transparent or translucent window adapted to make visible such color changes as will indicate the rupture of the fuse or an excess of temperature beyond a predetermined temperature in the casing.

Although specific experiments have been set forth in this specification, it is possible that many other variations in the ingredients of the indicating composition will give similar results. The invention is therefore to be understood as not in any way limited to the particular ingredients set forth in the various experiments, since these ingredients and the proportions thereof may be varied

within wide limits without affecting the merits of the invention.

In order to illustrate the practical use of the invention, various forms of fuses are illustrated in the drawings attached hereto; and the various methods of arranging the indicator materials within the fuse casing are also illustrated in the drawings, in which:

Figure 1 is a vertical section through a plug fuse of the well known Edison type provided with a transparent indicator window;

Figure 2 is a longitudinal section through a cylindrical fuse having a transparent outer wall, and illustrating one method of arranging a disc coated with indicating material under the fuse wire;

Figure 3 is a longitudinal section through a cylindrical fuse having an opaque outer wall or casing provided with an indicating window and illustrating another method of arranging a disc coated with indicating material between the fuse wire and the window;

Figure 4 is a longitudinal section through a cylindrical fuse having a transparent outer casing coated with the transparent and colorless indicating material forming a part of this invention;

Figure 5 is a vertical transverse section on the line 5—5 of Figure 2;

Figure 6 is a vertical transverse section on the line 6—6 of Figure 3; and

Figure 7 is a vertical transverse section on the line 7—7 of Figure 4.

As shown in Figure 1 of the drawings, the common plug fuse 1 has the usual body 2 of insulating material provided on its outer surface with screw threads on which a correspondingly shaped cylinder 3 of conducting material is mounted. A terminal 4 is secured as usual to the bottom of the plug and a fuse wire 5 extends from the bottom of the plug through a side of the body 2 and across the inner chamber 6 of plug into electrical contact with the other cylindrical terminal 3.

The plug is provided with the usual transparent window 7 and the fuse wire 5 extends across the chamber 6 and slightly spaced apart from the window 7. The fuse wire 5 is coated on the part which extends across the chamber 6 with a coating of any of the indicating material described in the previous experiments, and preferably with a coating of the material described in experiment 1. It will be understood, of course, that the powdered ingredients set forth in the various experiments must be provided with the necessary binder in order to make it adhere properly, either to the fuse wire or to the transparent window.

It must be understood that the ingredients may be arranged in their dry or powdered form within the casing in any position necessary to cause their being acted upon either by increase in temperature beyond a predetermined maximum temperature or by fusion caused by ignition with an electric spark.

The fuse shown in Figure 2 comprises a transparent cylindrical casing 8 having end walls 9 and 10 of insulating material through which the conductors 11 and 12 extend to be connected to the fuse wire 13. In this case, a small disc 14 is supported suitably in the casing 8 and is coated with the desired indicating material. The disc 14 is arranged sufficiently close to the fuse wire 13 so that the indicating material may undergo a decided color change upon increase of temperature in the casing 8 or by rupture of the fuse wire 13 with the formation of an arc.

The fuse shown in Figure 3 comprises a casing 15 having a window 16 suitably formed thereon. The conductors 17 and 18 extend through the plugs 19 and 20, respectively, at the ends of the casing 15 and are connected to the fuse wire 21. In this case the disc 22 coated with indicating material is arranged between the fuse wire 21 and the window 16, sufficiently close to the wire to cause color change of the coating material upon fusion of the wire 21 or increase in temperature in excess of a predetermined maximum.

In Figure 4 the fuse is illustrated as having a transparent outer wall 23 coated on its inner surface with indicating material 24, adapted to indicate by change of color a rupture of the fuse wire 25 or a decided increase beyond a predetermined maximum temperature.

The drawings are merely designed to show several examples of the practical use of the invention, and are not intended in any way to limit the use of the indicating material to fuses of the particular types shown. The invention may be practiced, as hereinbefore stated, by arranging the indicating material in any casing having a transparent window, to indicate a temperature within the casing in excess of any desired predetermined temperature. In other words, the invention is a very wide application and will be claimed accordingly.

In the claims appended hereto, it is to be understood that the expression "colored deposit" does not refer to the charring or discoloration of the transparent window, in common use in fuses, merely by the heat evolved in the fuse casing, or by the impact of the metallic gases caused by the melting or rupture of the fuse strip. The present invention is concerned only with the deposition of color on the transparent colorless part of the casing, as the result of heat applied to an indicator deliberately inserted in the complete fuse structure to perform this indicating function.

What I claim is:

1. A closed casing having a part thereof transparent and colorless, and means in said casing operable by heat to form a colored deposit upon said part to indicate a tempera-

ture within said casing beyond a predetermined maximum.

2. A casing having a part thereof transparent and colorless; a fuse strip supported in said casing; and means in said casing, operable by heat above a predetermined temperature derived from said strip, to form a colored deposit on said part.

3. A casing having a part thereof transparent and colorless, a fuse strip supported in said casing, a coating on said strip adapted to be changed chemically by heat above a predetermined temperature derived from said strip to form a colored deposit upon said part.

4. A casing having a part thereof transparent and colorless, a fuse strip supported in said casing, a transparent and colorless coating upon said part adapted, by heat beyond a predetermined temperature derived from said fuse strip, to form a colored deposit on said part.

5. A casing having a part thereof transparent and colorless, a fuse strip supported in said casing, a disc supported in said casing adjacent to said strip and coated with material adapted by heat beyond a predetermined temperature derived from said strip to form a colored deposit upon said part.

6. A casing having a part thereof transparent and colorless, a fuse strip supported in said casing, a disc supported in said casing separated from but closely adjacent to the side of the strip remote from said part, and a coating upon said disc operated by heat derived from said strip to form a colored deposit upon said part.

7. In a safety fuse, a casing having a transparent colorless window therein, a fuse strip within the plug, a coating of transparent colorless material applied directly to the inner surface of said window and separated from said strip and adapted to be operated by heat beyond a predetermined temperature derived from said strip to form a colored deposit upon said window.

8. In a safety fuse, a casing having a transparent colorless window therein, a fuse strip supported within said casing, a disc supported in said casing between said fuse strip and window, and a coating of indicating material on said disc adapted to be operated by heat derived from said strip to change color and thereby indicate disruption of the strip.

9. In a safety fuse, a casing having a transparent colorless window therein, a fusible conductor supported in said casing, and a coating of transparent colorless material on the inner surface of said window adapted to form a colored deposit upon the rise in temperature of said conductor beyond a predetermined maximum.

10. A fuse plug comprising a closed casing having a transparent window therein, a fuse strip within the casing, and means supported within the casing adjacent said strip and out of contact with said window to form a colored deposit upon said window when the strip becomes heated beyond a predetermined maximum temperature.

11. A fuse plug comprising a closed casing having a transparent window therein, a fuse strip within the casing, a disc supported in said casing between said strip and window and out of contact with said window, and means on said disc for automatically indicating the melting of said strip and rupture thereof.

12. A closed casing having a part thereof transparent and colorless, and means in said casing operable by heat to form a red colored deposit upon said part to indicate a temperature within said casing beyond a predetermined maximum.

13. A closed casing having a part thereof transparent and colorless, and means in said casing operable by heat to form a yellow colored deposit upon said part to indicate a temperature within said casing beyond a predetermined maximum.

14. A closed casing having a part thereof transparent and colorless, and means in said casing operable by heat to form a green colored deposit upon said part to indicate a temperature within said casing beyond a predetermined maximum.

In testimony whereof we affix our signatures.

MARIAN E. HASSELL.
EDWARD W. GORHAM.